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The impact of sit–stand office workstations on worker discomfort and productivity: A review

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ABSTRACT

This review examines the effectiveness of sit–stand workstations at reducing worker discomfort without causing a decrease in productivity. Four databases were searched for studies on sit–stand workstations, and five selection criteria were used to identify appropriate articles. Fourteen articles were identified that met at least three of the five selection criteria. Seven of the identified studies reported either local, whole body or both local and whole body subjective discomfort scores. Six of these studies indicated implementing sit–stand workstations in an office environment led to lower levels of reported subjective discomfort (three of which were statistically significant). Therefore, this review concluded that sit–stand workstations are likely effective in reducing perceived discomfort. Eight of the identified studies reported a productivity outcome. Three of these studies reported an increase in productivity during sit–stand work, four reported no affect on productivity, and one reported mixed productivity results. Therefore, this review concluded that sit–stand workstations do not cause a decrease in productivity.

1. Introduction

Prolonged seated work has been shown to result in increasing worker discomfort with respect to time (Fenety and Walker, 2002; McLean et al., 2001; Callaghan et al., 2010). Adjusting posture at an increased frequency throughout the workday is a proposed strategy used in an attempt to reduce discomfort (Karwowski et al., 1994; Liao and Drury, 2000). Posture adjustment can be accomplished in a range of different ways spanning from interventions as basic as adjusting seating position, to more extreme interventions such as changing whole body posture from a sitting to a standing position, increased breaks (McLean et al., 2001), or treadmill walking while working (John et al., 2009). It is based upon this extreme posture change that the sit–stand paradigm for office work was proposed (Karlqvist, 1998) and implemented. Although the logic behind installing sit–stand workstations in an office setting is based on sound ergonomics theory, historically sit–stand workstations have represented a small market share in North America but given the recent attention to chronic disease and total mortality associated with prolonged sitting (Patel et al., 2010) sit–stand stations have become a rapidly growing market share. Studies by Nerhood and Thompson (1994), Hedge and Ray (2004), and Vink et al. (2009) all showed that workers choose to stand for between 20 and 30% of their day when provided with a height adjustable workstation, while participating in their study. However, these studies were all for very brief periods (less than one month), and the participants were aware that they were participating in a study. To the contrary, there is also evidence showing a lack of compliance in using sit–stand workstations between six months and over a year after they are installed (Wilks et al., 2006). Through a small survey of companies with sit–stand workstations in Sweden, Wilks et al. (2006) found that as few as one in ten workers actually use the sit–stand feature of their workstation on a daily basis. Although there are a number of studies (Nerhood and Thompson, 1994; Roelofs and Straker, 2002; Davis et al., 2009) demonstrating the advantages/disadvantages of properly using a sit–stand workstation, the primary goal of this paper is to assemble a single, clear, compilation of this knowledge to support future evaluations and decisions surrounding adoption of these workstations for widespread use.

Vink and Hallbeck (2012) proposed the following definitions for comfort and discomfort respectively: "comfort is seen as pleasant state or relaxed feeling of a human being in reaction to its environment" (p. 271); and "discomfort is seen as an unpleasant state of the human body in reaction to its physical environment." (p. 271) Based upon these definitions, comfort and discomfort are not reciprocal terms, and the terms should not be used interchangeably

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(Zhang et al., 1996). Although measuring the feeling of discomfort is by its very nature subjective, there has been a link found between alternative objective measures (ex. pressure distribution) and subjective discomfort scores (De Looze et al., 2003). This link, combined with logistical limitations of worksite objective measures, has led to discomfort being used as a common outcome measure in assessing the effectiveness of sit–stand workstations. There is also evidence to suggest that musculoskeletal discomfort may be a predictor of future pain (Hamberg-van Reenen et al., 2008). Peak discomfort has been shown as a predictor of low-back, neck, and shoulder pain in a study of 1800 workers from 34 different companies. An important research question to be derived from all this is: does the sit–stand paradigm result in decreased worker perceived discomfort?

Worker productivity is another potential outcome measure that can be used in assessing the effectiveness of sit–stand workstations (Nerhood and Thompson, 1994; Dainoff, 2002; Husemann et al., 2009). Chapter 10 of the United States Department of Labor – Bureau of Labor Statistics (BLS) Handbook of Methods (BLS, 1997) defines productivity as, “output per hour”. The BLS Handbook goes on to explain that output is: “measured net of price change and inter-industry transactions.” (p. 90) With respect to the scientific and ergonomics literature reviewed here, price change and inter-industry transactions are difficult to obtain. In contrast, in the ergonomics literature office productivity is reported using alternative measures such as total keystrokes, completion of typing tasks, absenteeism rates, etc. Beyond this, many other factors can also contribute to BLS defined productivity (price and inter-industry transactions). Experience, communication, and creativity can also play a role in productivity; however, these concepts are extremely difficult to quantify and are rarely included in the sit–stand ergonomics literature.

There has been work showing a potential association between increasing discomfort and decreasing productivity, as measured by the completion of short typing tests and typing speed (Haynes and Williams, 2008; Liao and Drury, 2000). It has also been suggested that there may be an association between certain postures, other than a traditional sitting posture, and decreased worker productivity (Liao and Drury, 2000). A combination of the potentially opposing associations between increased productivity resulting from decreased worker discomfort in a sit–stand paradigm, and a decrease in productivity resulting from a standing posture leads to the question: does the sit–stand paradigm result in increased worker productivity?

This review is focused on the effectiveness of the sit–stand paradigm. Effectiveness can be measured as decreased worker discomfort and increased worker productivity. Specifically, measures of reduction in discomfort and increases in productivity through the introduction of specialized workstations, which allow for alternating between sitting and standing periodically throughout the office workday (sit–stand workstations), were examined.

2. Methods

2.1. Criteria for selecting studies for inclusion

2.1.1. Types of studies

All empirical research studies, which examined the effectiveness of sit–stand workstations or a sit–stand work paradigm in an office setting, were included. Both laboratory and field studies were included. Due to language restrictions, only studies published in the English language were included.

2.1.2. Types of participants

All included studies were performed on participants aged 18 or older. Studies conducted using experienced office workers and/or inexperienced office workers were both included. Studies examining healthy populations and/or populations with current, or a history of, low back pain were included.

2.1.3. Sit–stand workstation interventions

A sit–stand workstation was defined as a workstation that allowed a worker to perform the same task from either a seated or standing position with a self-adjustable worksurface height. Thus, the sit–stand work paradigm consists of a worker performing their duties while periodically alternating between sitting and standing positions throughout the day. All studies included involved a comparison of outcome measures for the sit–stand work condition to either: prolonged seated work, prolonged standing work, or both prolonged seated and prolonged standing work. All studies concerning the intervention of a sit–stand work paradigm were identified.

2.2. Search methods for identification of studies

Four databases (PubMed, ScienceDirect, Ergonomics Abstracts and Google Scholar) were searched using the following terms: “sit–stand” AND (“workstation” OR “workstations”). Searches were conducted between the dates of October 10th and October 20th, 2011, and were limited to articles published between 1950 and 2011. Included articles met at least the first three of the following five inclusion/exclusion criteria:

1. Primary research study that examined participants using sit–stand workstations
2. Participants were not an operator in a manufacturing process of any kind. Participants worked in an office setting (ie. VDT users and call center agents) or simulated office work in a laboratory setting
3. Sufficient detail about experimental methods was provided to critically assess quality. Such detail must have included: number of subjects, type of subject population, description of sit–stand paradigm(s) employed, description of randomization/controls, and description of outcome measures.
4. At least one outcome measure was participant subjective discomfort
5. At least one outcome measure was a productivity criteria (ie. keystrokes per minute, errors per keystroke, sick days, break time, etc.)

One additional criterion for the study was also considered, although the following was not deemed an inclusion/exclusion criteria:

6. Discomfort outcome measure included a specific low back discomfort score.

2.3. Study selection

The eligibility of each study found through the database searches was assessed by first reviewing the abstract and if there was potential for the inclusion criteria to be met the entire paper was obtained. Relevant data were extracted and the quality of the experimental design and relevance were evaluated. Population characteristics (age, gender, office work experience, history of low back pain), specific intervention paradigm (amount of time standing versus sitting, standing worksurface height, sitting worksurface height), worker adherence to intervention (how well did the worker follow the intervention), and outcome measures (discomfort, productivity, other kinematic measures) were extracted.